

HOW TO GUIDE

**The COMPARE module**  
**Facilitating project assessments and**  
**feasibility studies**



**energyPRO**



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## **About energyPRO**

energyPRO is a Windows-based modeling software package for combined techno-economic analysis and optimisation of complex energy projects with a combined supply of electricity and thermal energy from multiple different energy producing units.

The unique programming in energyPRO optimises the operations of the plant including energy storage (heat, fuel, cold and electrical storages) against technical and financial parameters to provide a detailed specification for the provision of the defined energy demands, including heating, cooling and electricity use.

energyPRO also provides the user with a detailed financial plan in a standard format approved by international banks and funding institutions. The software enables the user to calculate and produce a report of the emissions by the proposed project.

energyPRO is very user-friendly and is the most advanced and flexible software package for making a combined technical and economic analysis of multi-dimensional energy projects.

For further information concerning the applications of energyPRO please visit [www.emd.dk](http://www.emd.dk).

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# 1 Introduction to COMPARE

The COMPARE module has been on our most wanted list for a long time and finally it is here. It is now possible to contain a reference project and one or more alternatives to the reference project within a single energyPRO project. It is possible to calculate and reports across reference project and its alternatives.

To use the COMPARE module, you need to buy access to the COMPARE module and to register the module. Furthermore, you must have at least a registered DESIGN module. To get the full potential of the module the FINANCE module is needed. The combination of COMPARE and FINANCE/ACCOUNTS adds more value to the FINANCE and ACCOUNTS modules.

By the introduction of the COMPARE module energyPRO offers a coherent way to calculate the classical financial key figures used in project assessments and feasibility studies based on differences between alternatives.

This COMPARE module will help you getting an overview of a project and its alternatives without having them in separate files. It is now possible to update technical and economic assumptions without having to change them in separate files. Furthermore, it is possible to compare the projects in new COMPARE reports concerning energy conversion and economy. In the following the example "Cogeneration plant on a Day Ahead market, extended with a heat pump or wood boiler. 10 year calculation" is used as base. This example is distributed along with the energyPRO installation.

## 1.1 The Changes in the energyPRO Graphical user interface (GUI)

There are only a few changes in the graphical user interface (GUI), meaning that it should be easy for existing energyPRO users to get started. At first glance there are two differences. The first is the COMARE overview button at the menu bar, the second is tabs at the bottom of the energyPRO main form containing the reference and the alternatives to be compared, see the Figure 1.1. These tabs are used for toggling between alternatives.

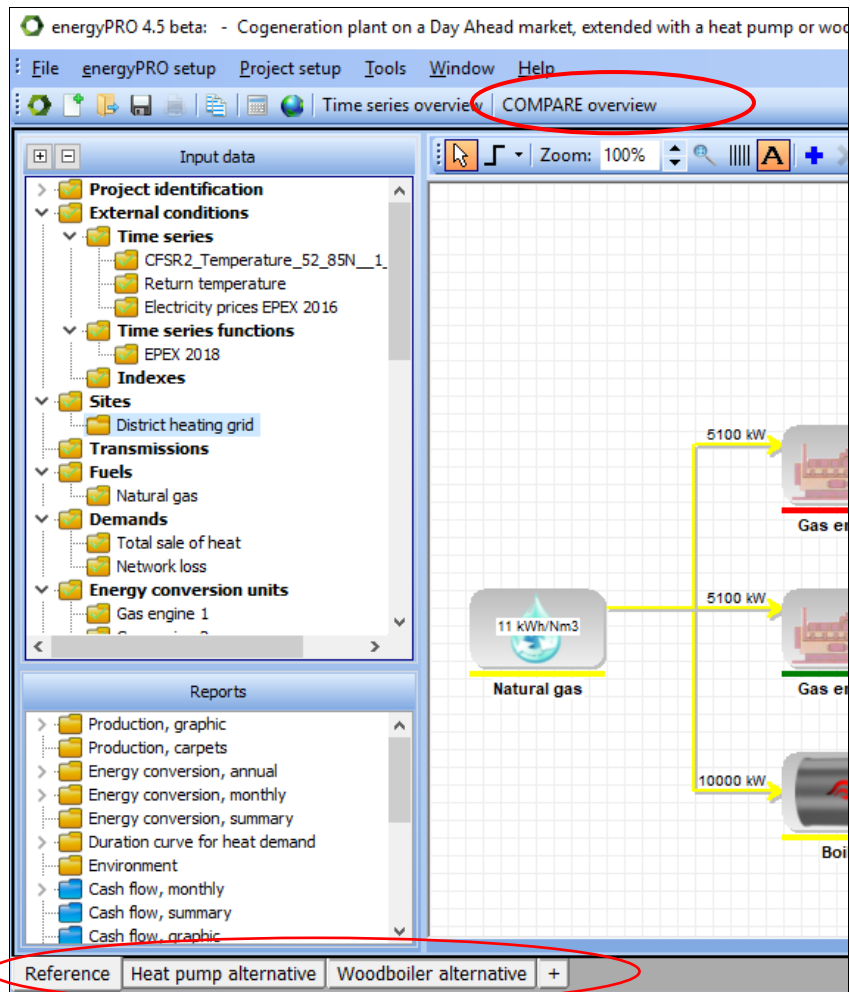


Figure 1.1: COMPARE changes in the energyPRO main window

Pressing the COMPARE overview button creates a table that gives an overview of which elements that are changed across the reference and its alternatives.

In Figure 1.2 you can see that among others, "Wood chips" are added as a fuel in the "Woodboiler alternative", and that the "Total sale of heat" demand is changed in the "Heat pump alternative".

| Root                    | Data Name               | Heat pump alternative | Woodboiler alternative |
|-------------------------|-------------------------|-----------------------|------------------------|
| Fuels                   | Wood chips              |                       | Added                  |
| Demands                 | Total sale of heat      | Changed               |                        |
| Energy conversion units | Elec Heatpump           | Added                 |                        |
| Energy conversion units | Wood chips boiler       |                       | Added                  |
| Fuel costs              | Purchase of wood chips  |                       | Added                  |
| Operation&Maint.        | Wood chips boiler       |                       | Added                  |
| Heat pump               | Maintenance             | Added                 |                        |
| Heat pump               | Purchase of electricity | Added                 |                        |
| Heat pump               | Grid tariffs            | Added                 |                        |
| Investments             | Investment in HP        | Added                 |                        |
| Investments             | Wood chip boiler        |                       | Added                  |

Figure 1.2: Compare overview window

Another helpful feature is that objects that are added or changed are highlighted. That is done both in the tree view and the sites view belonging to the selected alternative, see Figure 1.3.



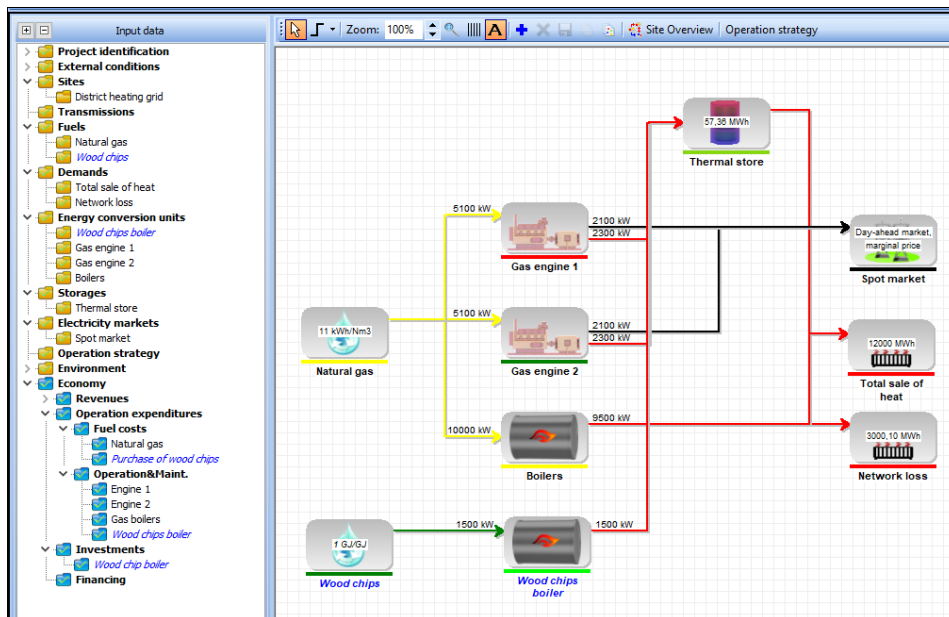


Figure 1.3: Changes/differences compared to the reference are highlighted

In this example the Woodboiler alternative is selected via its tab. The changes are easily seen as blue italic text. As seen the fuel "Wood chips" and the energy conversion unit "Wood chips boiler" are objects that differs from the reference. The same is for instance the case with the payment "Purchase of wood chips".

## 1.2 Basic COMPARE operations

By right clicking at one of the tabs at bottom of the energyPRO main window you get access to a popup menu, see Figure 1.4. The Basic operations are "Clone", "Rename", "Delete" and "Save as".

The "Clone" functionality Clone/copies the reference/alternative represented by the tab. In the example for instance cloning the "Reference" will make an exact copy of the "Reference" and adds a new tab "Reference Copy", similarly cloning "Heat pump alternative" adds a new tab "Heat pump alternative Copy".

The "Rename" functionality gives access to renaming the selected alternative (not possible for the "Reference").

The "Delete" functionality deletes the selected alternative (not possible for the "Reference").

The "Save as" functionality gives access to saving the selected alternative or the reference as a new energyPRO project.

**Popup menu**

**Operations on tabs x and +**

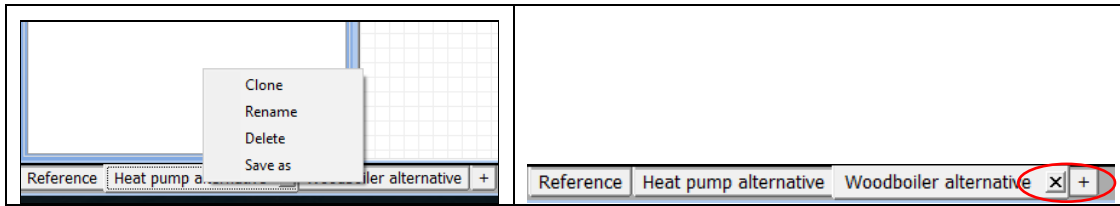


Figure 1.4: Compare basic operations

There are two other create and delete options. The first is that an alternative can be created by pressing the small tab with the + sign creating a copy of the reference. The second is that the active alternative can be deleted by pressing the small X button on the tab of the active alternative.

### 1.3 Editing objects – Only a few changes for users familiar with energyPRO

Users familiar with energyPRO will not experience changes when editing objects in the "Reference". In the alternatives there are a few exceptions.

The exceptions are related to the windows "Project identification", "External conditions" and "Economy". These exceptions are all exceptions, where the "Reference" rules and where it does not make sense having different values in the "Reference" and its alternatives.

In the "Project identification" it is NOT possible to change the projects calculation module in the alternatives.

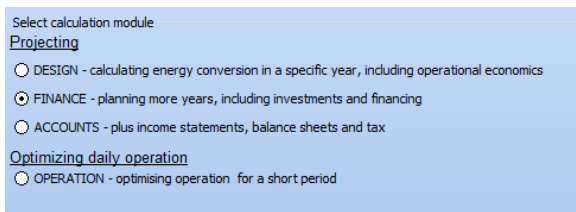


Figure 1.5: Calculation module only to be changed in the "Reference"

In "External conditions" it is NOT possible to change the planning period in the alternatives

In "Economy" it is NOT possible to make changes in the alternatives.

### 1.4 Synchronizing

One of the major advantages when using the compare module compared with having a set of projects each in its own file is that changes made in the "Reference" are automatically synchronized with the alternatives when changes are made.

The objects that are synchronized are easily found. It is the objects which have their names written in black and - NOT highlighted with blue italic text. Hence the blue Italic objects are objects not synchronized with the reference. This is the case where an object are added in the alternative and not found in reference OR the objects are changed in the alternative. An object changed in an alternative will not affect the reference / other alternatives.

If an object is added in the "Reference" it will be populated in all alternatives.

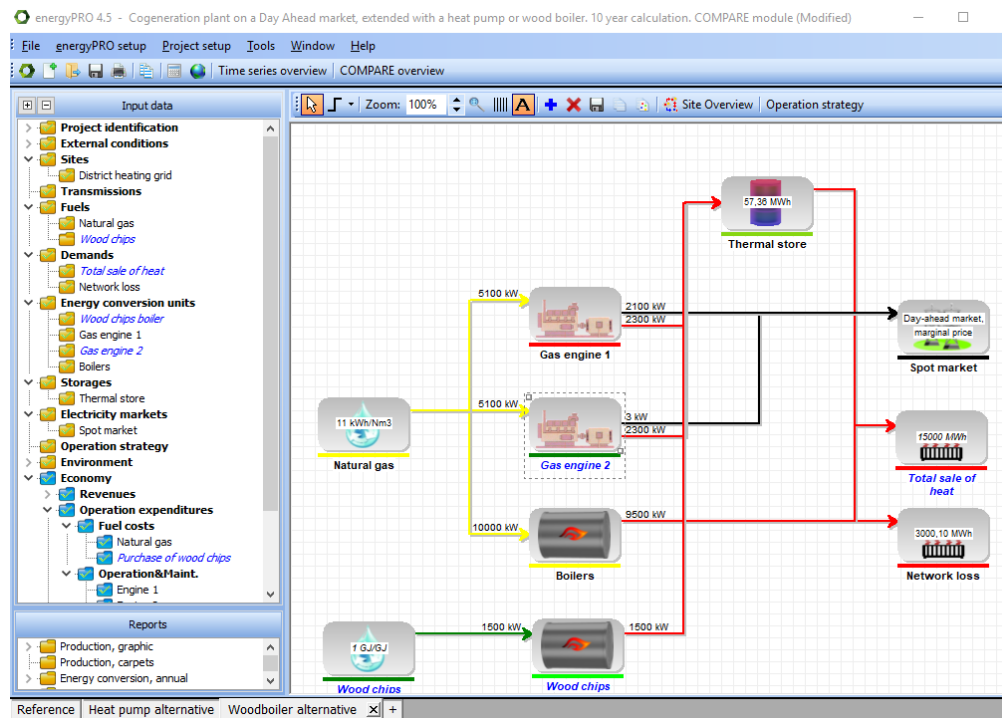


Figure 1.6: Resynchronization from tree view or from sites view

It is possible to resynchronize an object if wanted. This is done by right clicking the objects either in the selected alternatives tree view or the sites view.

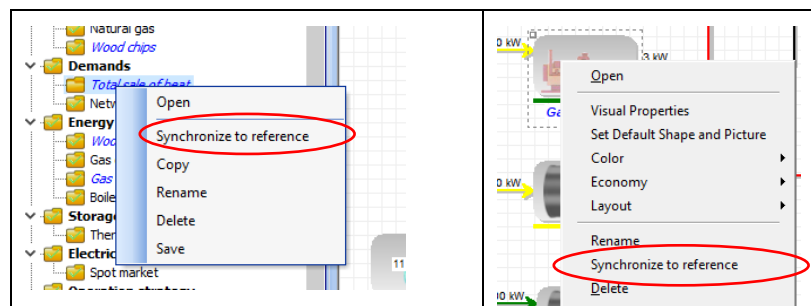


Figure 1.7: Resynchronization from tree view or from sites view menus.

There are two resynchronization situations. First, if the object is present in the "Reference". In that case when synchronizing the chosen object in the alternative is substituted with the corresponding object found in the "Reference". Second, the object is added in the alternative (not present in the reference). In that case then object is deleted from the alternative.

## 2 The COMPARE Reports

Along with the COMPARE module comes a set of new reports helping the user to compare the "Reference" and its alternatives. The available reports are depending on, which energyPRO module that are selected, see availability in Figure 2.1.

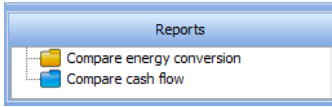
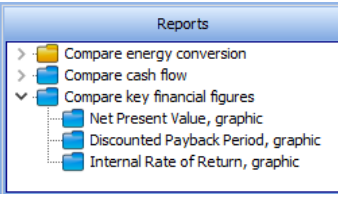
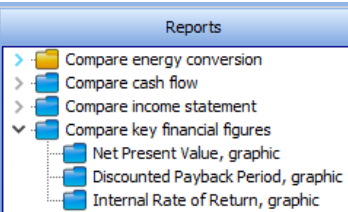
| DESIGN/OPERATION  | FINANCE   | ACCOUNTS   |
|---|---|--|
|  |  |  |

Figure 2.1: Available report corresponding to the selected energyPRO module

The reports “Compare energy conversion”, “Compare cash flow” and “Compare income statement” are presented as annual report in FINANCE and ACCOUNTS otherwise a single report for the planning period.

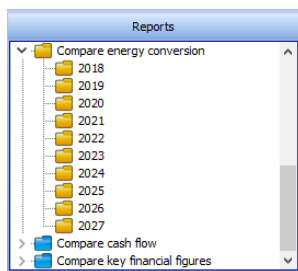


Figure 2.2: Most COMPARE Reports are presented as annual reports in FINANCE and ACCOUNTS

All together these reports makes a significant improvement of energyPRO capability to facilitate project assessments and feasibility studies

## 2.1 Compare energy conversion

This report pictures a comparison of the energy conversion between the “Reference” and its alternatives, see Figure 2.3. The report structure is basically the same as the “Energy conversion monthly” report known by existing energyPRO users. The main difference is that the month columns are substituted by reference/alternative columns.

|                                      |                    | Reference | Heat pump alternative | Woodboiler alternative |
|--------------------------------------|--------------------|-----------|-----------------------|------------------------|
| Calculated period: 01-2018 - 12-2018 |                    |           |                       |                        |
| Heat demand                          | [MWh]              | 15.079,6  | 15.079,6              | 15.079,6               |
| Electricity produced by energy units | [MWh]              | 5.098,8   | 1.003,8               | 2.047,5                |
| Electricity consumed by energy units | [MWh]              | 0,0       | 3.494,0               | 0,0                    |
| Exported electricity                 | [MWh]              | 5.098,8   | 1.003,8               | 2.047,5                |
| Peak                                 | [MW]               | 4.200     | 4.200                 | 4.200                  |
| Imported electricity                 | [MWh]              | 0,0       | 3.494,0               | 0,0                    |
| Peak                                 | [MW]               | 0,000     | 1,000                 | 0,000                  |
| Energy unit: Gas engine 1            |                    |           |                       |                        |
| Fuel consum.                         | [Nm <sup>3</sup> ] | 580.472,7 | 111.272,7             | 240.163,6              |
| Fuel consum.                         | [MWh]              | 8.385,2   | 1.224,0               | 2.641,8                |
| Heat prod.                           | [MWh]              | 2.879,6   | 552,0                 | 1.191,4                |
| Elec. prod.                          | [MWh]              | 2.629,2   | 504,0                 | 1.087,8                |
| Operating hours                      | [hours]            | 1.252,0   | 240,0                 | 518,0                  |
| Full load operating hours            | [hours]            | 1.252,0   | 240,0                 | 518,0                  |
| Turn ons                             | [Turn ons]         | 205,0     | 38,0                  | 92,0                   |
| Energy unit: Gas engine 2            |                    |           |                       |                        |
| Fuel consum.                         | [Nm <sup>3</sup> ] | 545.236,4 | 110.345,5             | 211.881,8              |
| Fuel consum.                         | [MWh]              | 8.007,6   | 1.243,8               | 2.320,7                |

Figure 2.3: Compare energy conversion

## 2.2 Compare Cashflow and Compare income statement reports

These reports picture a comparison of the Cash flow/ income statements between the "Reference" and its alternatives, see Figure 2.4 . The report structure is basically the same as the "Cash flow, summary" and "Income statement, summary" reports known by existing energyPRO users. The only difference is that the columns representing annual values are substituted by columns containing annual values from a specific year found in the reference/alternative.

**Cogeneration plant on a Day Ahead market, extended with a heat pump or wood boiler. 10 calculation. COMPAREmodule.epp**

The reference situation is an existing CHP plant with two CHP units

**Compare cash flow**

Calculated period: 01-2018 - 12-2018  
(All amounts in EUR)

|                                       | Reference      | Heat pump alternative | Woodboiler alternative |
|---------------------------------------|----------------|-----------------------|------------------------|
| <b>Revenues</b>                       |                |                       |                        |
| <b>Sale of heat</b>                   |                |                       |                        |
| Total sale of heat                    | 452.983        | 452.983               | 452.983                |
| <b>Sale of heat Total</b>             | <b>452.983</b> | <b>452.983</b>        | <b>452.983</b>         |
| <b>Sale of electricity</b>            |                |                       |                        |
| Sale of electricity                   | 248.897        | 64.595                | 113.142                |
| <b>Sale of electricity Total</b>      | <b>248.897</b> | <b>64.595</b>         | <b>113.142</b>         |
| <b>Revenues Total</b>                 | <b>701.881</b> | <b>517.578</b>        | <b>566.126</b>         |
| <b>Operation expenditures</b>         |                |                       |                        |
| <b>Fuel costs</b>                     |                |                       |                        |
| Natural gas                           | 610.712        | 67.289                | 202.333                |
| Purchase of wood chips                | 0              | 0                     | 151.654                |
| <b>Fuel costs Total</b>               | <b>610.712</b> | <b>67.289</b>         | <b>353.986</b>         |
| <b>Operation&amp;Maint.</b>           |                |                       |                        |
| Engine 1                              | 15.775         | 3.024                 | 6.527                  |
| Engine 2                              | 14.818         | 2.999                 | 5.758                  |
| Gas boilers                           | 11.411         | 34                    | 2.789                  |
| Wood chips boiler                     | 0              | 0                     | 31.594                 |
| <b>Operation&amp;Maint. Total</b>     | <b>42.004</b>  | <b>6.056</b>          | <b>46.668</b>          |
| <b>Heat pump</b>                      |                |                       |                        |
| Maintenance                           | 0              | 27.952                | 0                      |
| Purchase of electricity               | 0              | 74.014                | 0                      |
| Grid tariffs                          | 0              | 66.386                | 0                      |
| <b>Heat pump Total</b>                | <b>0</b>       | <b>168.352</b>        | <b>0</b>               |
| <b>Operation expenditures Total</b>   | <b>652.716</b> | <b>241.698</b>        | <b>400.655</b>         |
| <b>Net Cash from Operation</b>        | <b>49.165</b>  | <b>275.880</b>        | <b>165.471</b>         |
| <b>Investments</b>                    |                |                       |                        |
| Investment in HP                      | 0              | 1.500.000             | 0                      |
| Wood chip boiler                      | 0              | 0                     | 1.000.000              |
| <b>Total Investments</b>              | <b>0</b>       | <b>1.500.000</b>      | <b>2.500.000</b>       |
| <b>Total Interest on Cash Account</b> | <b>0</b>       | <b>0</b>              | <b>0</b>               |
| <b>Cash Account</b>                   | <b>49.165</b>  | <b>-1.224.120</b>     | <b>-834.529</b>        |
| <b>Cash Account</b>                   | <b>49.165</b>  | <b>-1.224.120</b>     | <b>-834.529</b>        |

Figure 2.4: Compare cash flow

## 2.3 Compare financial key figures

The combination of COMPARE and FINANCE/ACCOUNTS adds a solid basis for facilitating project assessments and feasibility studies.

The introduction of the COMPARE module offers a coherent way to calculate the classical financial key figures used in project assessments and feasibility studies based on differences between alternatives. Those key figures are:

- Net present value
- Payback time
- Internal rate of return

These financial key figures are presented in four Compare reports. The first is the "Compare financial key figures" report placed in the Reports root and contain a comparison of the financial key figures, Net present value, payback time and Internal rate of return. The three other reports are graphic reports of each of these key figures.

### 2.3.1 Compare financial key figures (Root report)

The Compare financial key figures report includes all the above mentioned key figures in mix of text and graphic. An example of the key figures is shown in Figure 2.5 to Figure 2.7

The Net present values shown in Figure 2.5. are the Net present values of the alternatives relative to the reference scenario. The net present values for the main payments are shown for each alternative followed by a graphic showing the aggregated present value for each alternative.

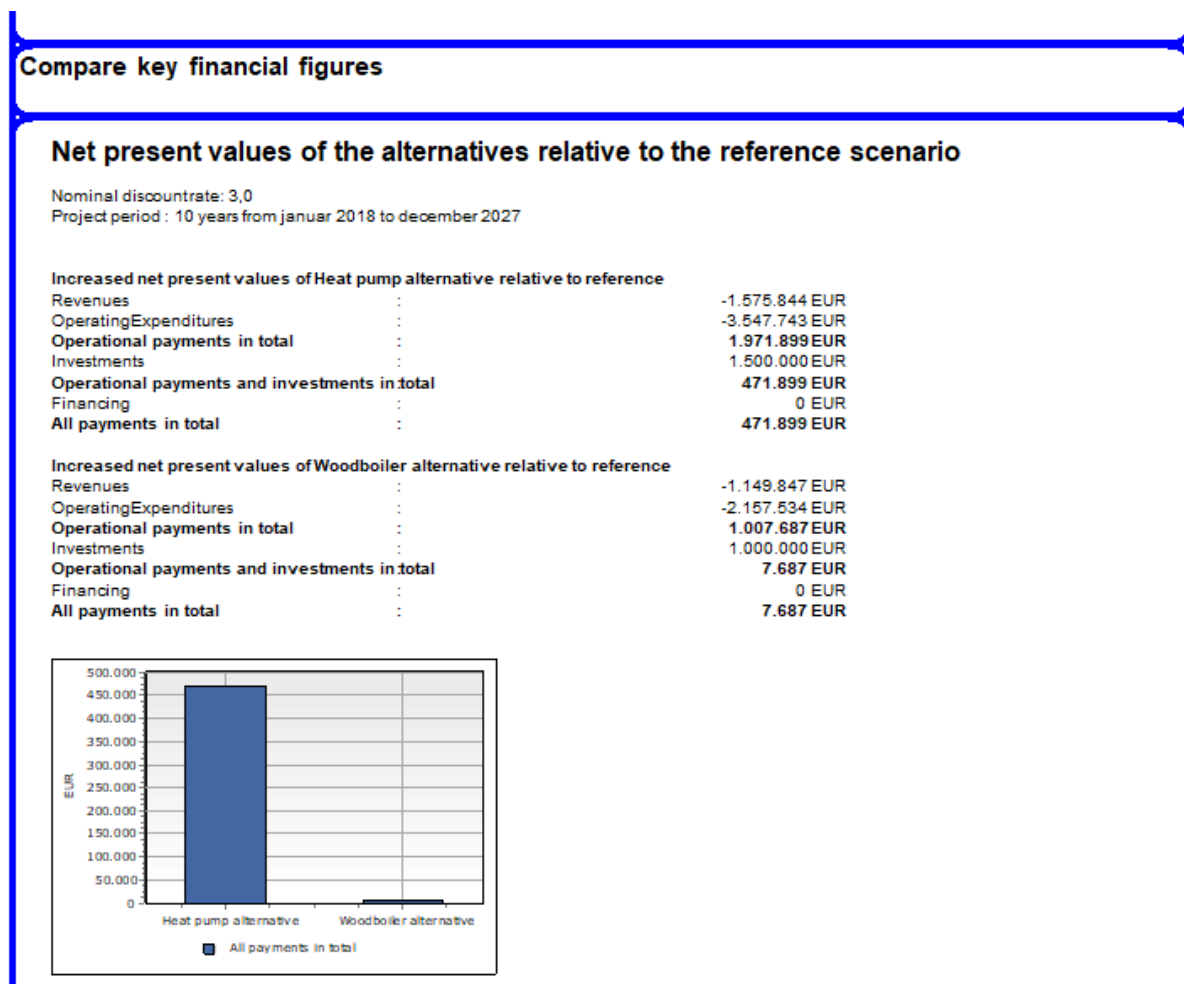


Figure 2.5: Compare key financial figures. Net present value.

The Payback time is shown both as a number for each alternative and a graphic interpretation, see Figure 2.6. The graphs show the discounted accumulated cashflow for the alternatives. The Payback time is the time it takes before the accumulated cashflow turns positive.

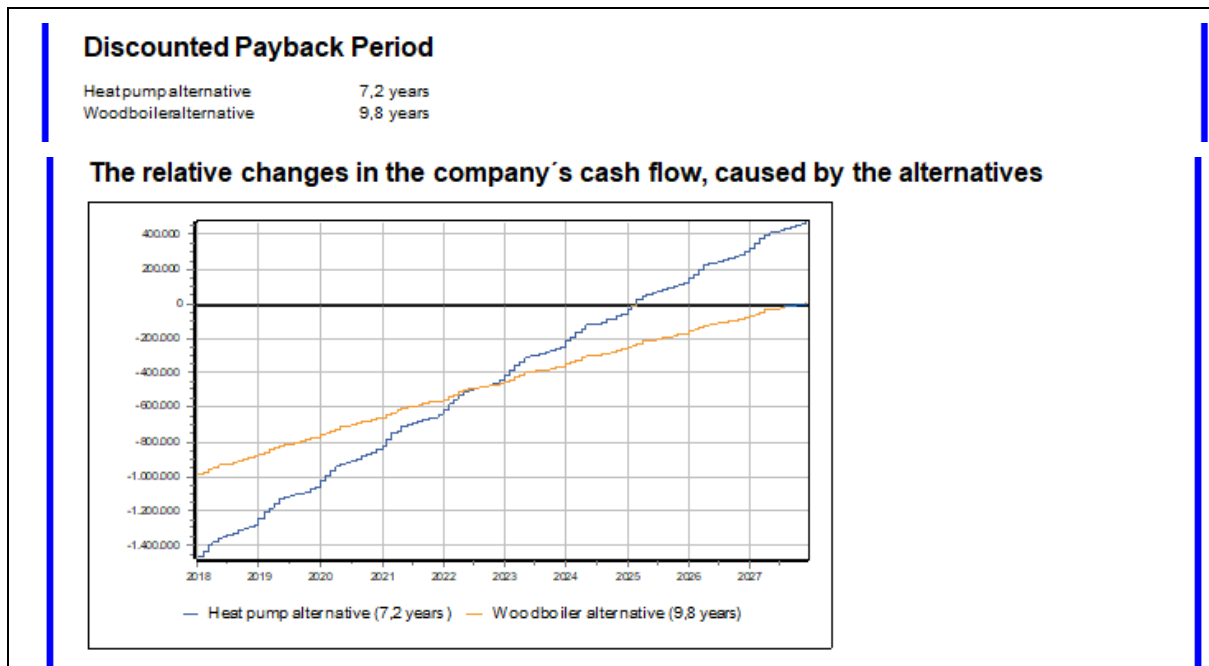


Figure 2.6: Compare key financial figures. Net present value

The internal rate of return is shown in Figure 2.7. The Internal rate of return is a discount rate that makes the net present value (NPV) of all cash flows caused by an alternative equal to zero. IRR calculations rely on the same formula as NPV does.

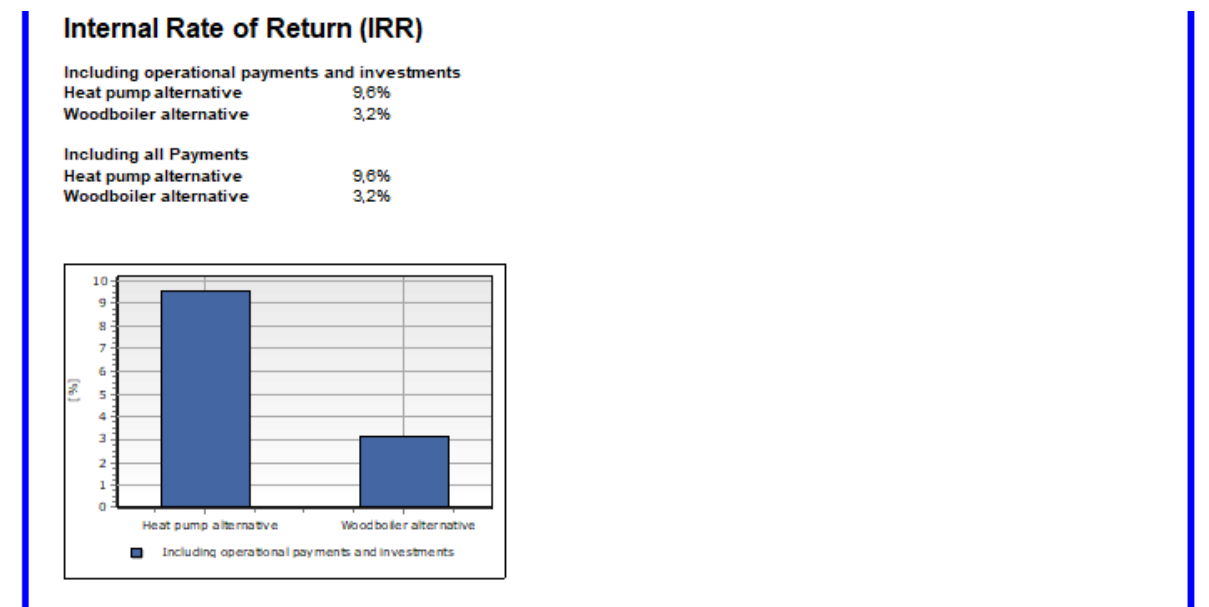


Figure 2.7: Compare cash flow. Internal rate of return

### 2.3.2 Net present value, graphic

This report shows the Net present value of the alternatives compared with the "Reference". The Net present values are represented as a column for each alternative.



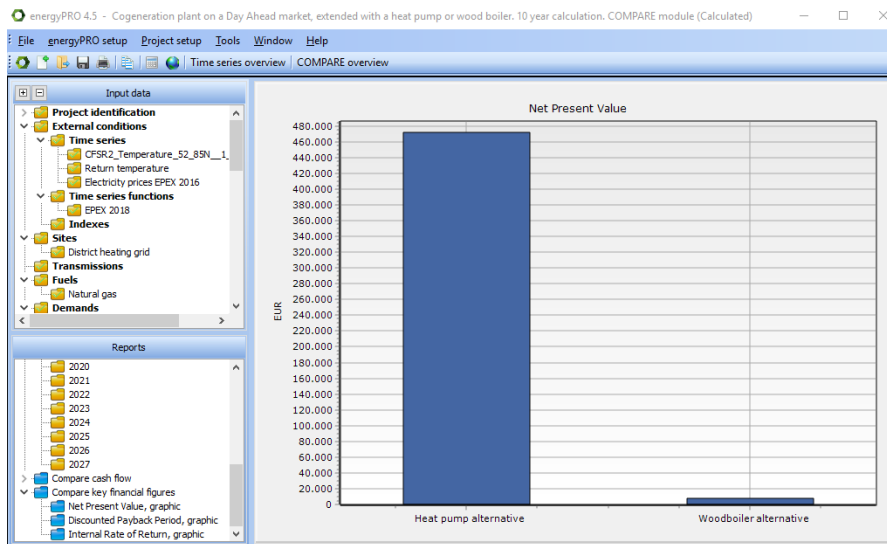


Figure 2.8: Net present value, graphic report

### 2.3.3 Discounted payback period, graphic

This Discounted Payback Period report shows the alternatives compared with the “Reference”, see Figure 2.9, represented by their monthly accumulated discounted payments compared with the “Reference”. The month where the monthly accumulated discounted payments turn positive is the projects payback period. The payback time is also indicated at legends of graph.

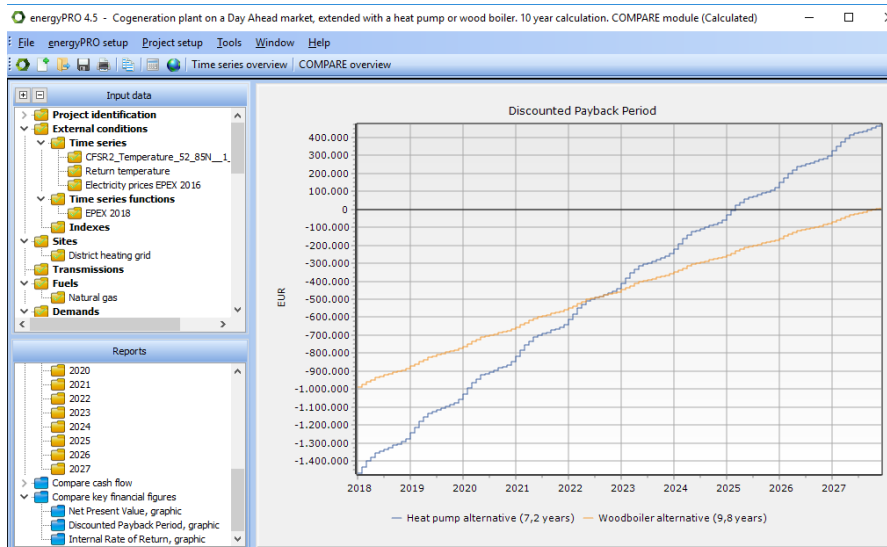


Figure 2.9: The payback time, graphic report

### 2.3.4 Internal rate of return, graphic

The Internal rate of Return

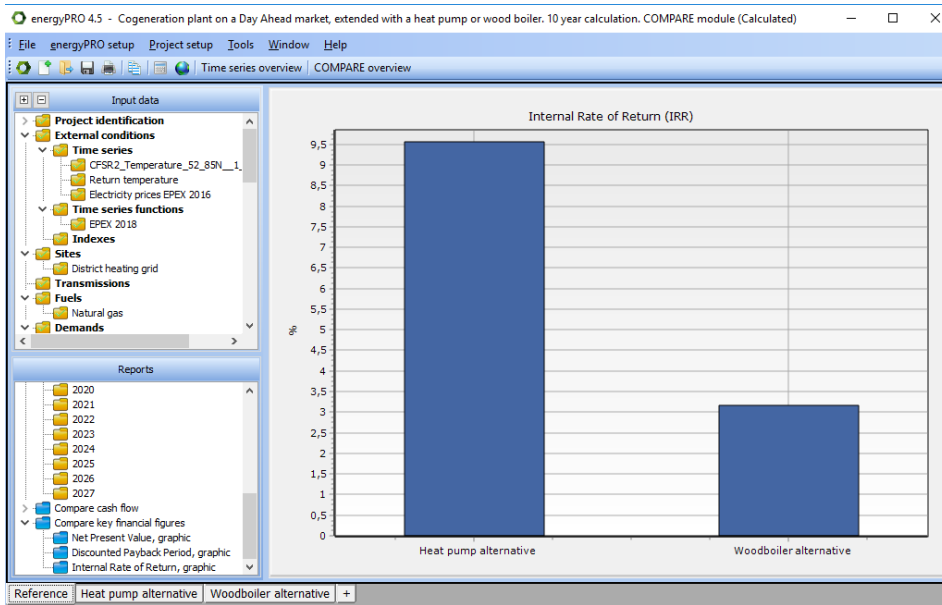


Figure 2.10: The Internal rate of return, graphic report